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**SANITIZED VERSION OF EFFECTS OF U-234 CONTENT
IN THE K-25 DIFFUSION CASCADE**

(Sanitized Version of CRD Document KZ-34)

Compiled by
S. G. Thornton
Environmental Management Division
OAK RIDGE K-25 SITE
for the Health Studies Agreement

July 31, 1996

Oak Ridge K-25 Site
Oak Ridge, Tennessee 37831-7314
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
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under Contract DE-AC05-84OR21400

This document has been approved for release
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8/6/96
Date

CARBIDE AND CARBON CHEMICALS CORPORATION

PROCESS DIVISION

PROCESS DESIGN AND DEVELOPMENT DEPARTMENT

Date: December 5, 1946

INVENTORIED
NOV 9 1951
By <i>AR</i>

EFFECTS OF U-235 CONTENT IN REL T-25

DIFFUSION CASCADE

Written by: J. Shacter

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By *KK*CARBIDE AND CARBON CHEMICALS CORPORATIONPROCESS DIVISIONPROCESS DESIGN AND DEVELOPMENT DEPARTMENT

To: A. P. Huber

Date: December 5, 1946

EFFECTS OF U-234 CONTENT IN THE K-25DIFFUSION CASCADE

Written by: J. Shacter

Abstract

Revised methods of laboratory analysis resulted in a better estimate of the 234 contents of the K-25 plant at the present conditions. The latest figures indicate a fairly high tops concentration (see fig. 1). The effects of this state on equilibrium time and production methods are discussed. Product removal at a reasonable rate within fairly liberal limits of concentration is suggested.

Introduction

Productivity calculations have been based in the past on a two component system of U-235 and U-238. It was realized that the U-234 content would tend to increase the combined production of U-235 and U-234 at high product concentrations very slightly above the predicted value. At low product concentrations the predictions were based on actual plant data which, before being reported, had been corrected for the U-234 content by the laboratory.

It becomes necessary to review the performance of the plant in the light of three recent developments:

- (1) Production is to be based on U-235 content alone. This factor is not serious at lower product purities, where the U-234 content in the product is small, and where changes of the product purity in the neighborhood of a few percent hardly affect the output in terms of Kgs of X/day.

At the present operating range small changes in the tops concentration do effect comparatively large changes in X output.

- (2) The reported U-234 tops concentration was in error and had to be revised upward.
- (3) The time to reach the final redefined tops concentration (41380003% of 235) exceeded the predicted time, and the U-235 concentration seemed to tend towards a lower equilibrium value.

Discussion and Conclussions

The approximate gradients of U-235 and U-234 were plotted against K-25 stage numbers (fig. 1). These curves are as reliable as the data on which they are based.

U-235 and U-234 each was chosen as a key component, and in each case the average molecular weight of the remaining two constituents (U-234 and U-238 for the case in which U-235 was chosen as key component) was calculated.

The ideal separation factor for the key component was then computed. The separation factors (α) were then plotted for both key components against K-25 stage number (fig. 2).

The effect on the U-235 ψ values of the plant by the presence of U-234 can be seen in the shape of the heavier curve of fig. 2. ($\alpha_{235} - 1$) values throughout the plant can be obtained by subtracting 1.0 from the ordinate values of the curve. The ratio of plant ψ values to ($\alpha - 1$) is essentially the same for the sections and is approximately

It can be seen from the curve that there is no noticeable effect below the 304 section, some effect in the 305 section, and a considerable decrease in ψ value in the 306 section, with a maximum decrease of ψ at the very top stage of the plant to about 50% of its "normal" value!

A decrease of ψ value can be related to a decrease in productivity with the use of the $\frac{\Delta P}{P} / \frac{\Delta \psi}{\psi}$ values in the report "Effect of Differential Changes on Productivity at 412000%", 9/24/46, by W. G. Siedenbureg. From these values a small effect on productivity (little over 2%) is indicated. This figure should be regarded with considerable caution since:

- (1) Factors at the present top concentration would exceed those at 412000% for the upper portions of the plant by a sizeable margin.
- (2) Factors listed in that report are point slope values, tangents to a curve which is steeper for lower ψ values.

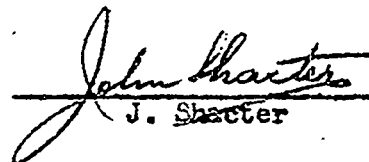
In view of the considerations mentioned above, the actual decrease in productivity at the present U-234 gradient may well be of a considerably higher order of magnitude than 2%. The only favorable factor is the feasibility of a reduction of U-234 tops concentration at a reasonable product rate from a total reflux value, thus leading to a corresponding increase in average molecular weight of the non-key component-mixture of U-234 and U-238.

It, therefore, seems advisable to choose a high enough product rate and limit that rate only by a lower limit in top purity - this lower limit being the minimum possible value acceptable to the consumer above 4138008%.

More conservatism in these limits could result in a very long period of high U-234 concentrations and thus inefficient top sectional operation. This type of performance results in a flatter U-235 gradient in the top sections which are affected by high 234 contents, and thus in overstrained bottom sections which must produce at too steep a gradient to make up for the lack of top performance. That gradient would correspond closely to the one predicted for a combined U-235 and U-234 tops concentration of 41380001%.

There is little chance that a reasonable rate of production cannot be sustained by the plant after an initial number of days, and the lower concentration limit would assure that the product is still of value to the consumer.

It is very likely that the U-235 product concentration will slightly decrease at first, but that decrease will also be accompanied by corresponding decrease in U-234 concentration, and as soon as the new equilibrium establishes itself, the U-235 concentration may be expected to rise again without any necessary reduction in the product rate.


J. Shacter

Approved by:


G. A. Garrett

JS/ap

DISTRIBUTION

1. K-25 Site Records (RC)
2. ChemRisk/Shonka Research Associates
3. DOE Public Reading Room
4. S. G. Thornton (K-25 EMD)